CUET (UG) Exam Paper 2024

National Testing Agency

PHYSICS

(Solved)

[This includes Questions pertaining to Domain Specific Subject only]

Time Allowed: 45 Mins. **Maximum Marks: 200**

General Instructions :

- ***(i)*** *This paper consists of 50 MCQs, attempt any 40 out of 50 .*
- ***(ii)*** *Correct answer or the most appropriate answer: Five marks (+5) .*
- ***(iii)*** *Any incorrect option marked will be given minus One mark (–1) .*
- ***(iv)*** *Unanswered/Marked for Review will be given No mark (0) .*
- ***(v)*** *If more than one option is found to be correct then Five marks (+5) will be awarded to only those who have marked any of the correct options .*
- ***(vi)*** *If all options are found to be correct then Five marks (+5) will be awarded to all those who have attempted the question .*
- ***(vii)*** *If none of the options is found correct or a Question is found to be wrong or a Question is dropped then all candidates who have appeared will be given five marks (+5).*
- ***(viii)*** *Calculator / any electronic gadgets are not permitted .*

1. In an electromagnetic wave, the ratio of energy densities of electric and magnetic field is ________. Fill in the blank with the correct answer from the options given below.

(1) 1 : 1 **(2)** 1 : c

(3) c : 1 **(4)** 1 : c^2

Ans. **Option (1) is correct.**

Explanation:

The energy density in electric field is $\frac{1}{2}\varepsilon_0 E_0^2$

The energy density in magnetic field is $\frac{B_0}{2\mu_0}$.

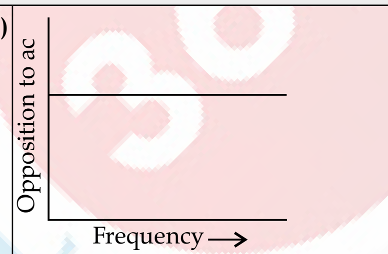
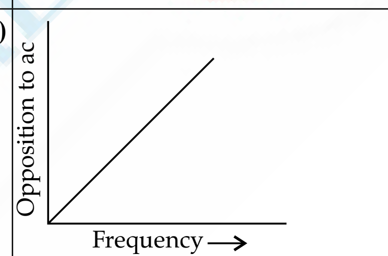
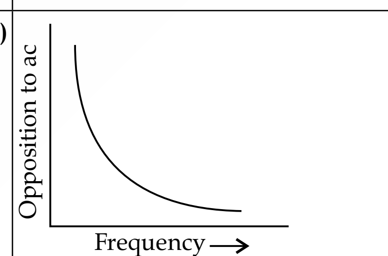
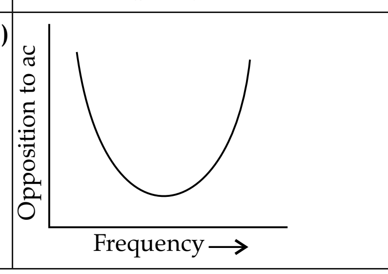
Their ratio is $\frac{\frac{1}{2}\varepsilon_0 E_0^2}{\frac{B_0}{2\mu_0}} = \varepsilon_0\mu_0\left(\frac{E_0}{B_0}\right)^2$

$= \frac{1}{c^2}\times c^2 = 1$

As, $\left[\frac{1}{c^2} = \varepsilon_0\mu_0, \quad c = \frac{E_0}{B_0}\right]$

Alternative,
As both have same dimensional formula, so their ratio is 1:1.

2. Match List-I has four graphs showing variation of opposition to flow of ac versus frequency with circuit characteristic in List-II.

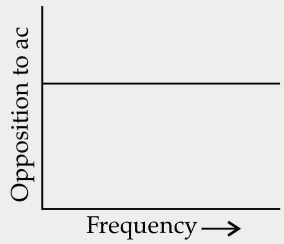
	LIST I		LIST II
(A)		**I**	Impedance
(B)		**II**	Capacitive reactance
(C)		**III**	Inductive reactance
(D)		**IV**	Resistance

Choose the correct answer from the options given below.

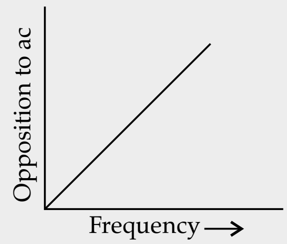
(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)
(2) (A)-(IV), (B) - (III), (C) - (II), (D)-(I)
(3) (A)-(I), (B)-(II), (C)-(IV), (D)-(III)
(4) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

Ans. Option (2) is correct.

Explanation: Resistance(R) is independent of frequency.

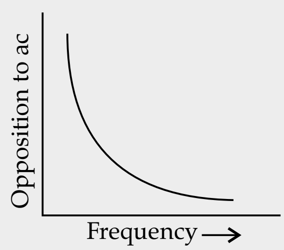


Inductive reactance $X_L = \omega L$,
So, $X_L \propto \omega$



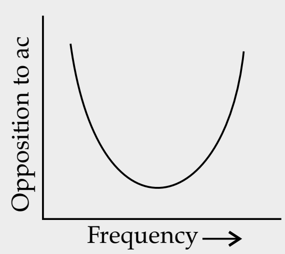
Capacitive reactance, $X_C = \frac{1}{\omega C}$

So, $X_C \propto \frac{1}{\omega}$



Impedance, $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$

At resonance $\omega L = \frac{1}{\omega C}$, and Z is minimum, i.e., R.



3. Of the following, the correct arrangement of electromagnetic spectrum in decreasing order of wavelength is ___________.
Fill in the blank with the correct answer from the options given below.

(1) Radio waves, X-rays, Infrared waves, microwaves, visible waves
(2) Infrared waves, microwaves, Radio waves, X-rays, visible waves
(3) Radio waves, microwaves, Infrared waves, visible waves, X-rays
(4) X-rays, visible waves, Infrared waves, microwaves, Radio waves

Ans. Option (3) is correct.

***Explanation*:** The decreasing order of wavelength in electromagnetic spectrum is

Radiowaves > microwaves > IR rays > visible light > UV-rays > X-rays > γ-rays

4. Match Electromagnetic waves listed in column I with Production method/device in column II.

	Column-I Electromagnetic waves		Column-II Production method/device
A	Microwaves	**I**	LC oscillator
B	Infrared	**II**	Magnetron
C	X-rays	**III**	Vibration of atoms/ molecules
D	Radio waves	**IV**	Bombarding large atomic number fast moving electrons

The correctly matched combination is as in option:

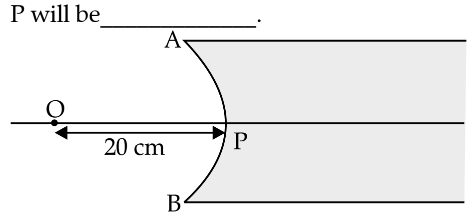
(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)
(2) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
(3) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)
(4) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

Ans. Option (2) is correct.

***Explanation*:**

Electromagnet waves	Production methods
Microwave	Magnetron valve
Infra Red	Vibration of atoms/molecules
X-Ray	Bombarding large atomic number metal target with fast moving electrons.
Radio wave	LC-oscillation

5. In the figure given below, APB is a curved surface of radius of curvature 10 cm separating air and a transparent material $\left(\mu = \frac{4}{3}\right)$. A point object O is placed in air on the principal axis of the surface 20 cm from P. The distance of the image of O from P will be_____________.



Fill in the blank with the correct answer from the options given below.

(1) 16 cm left of P in air
(2) 16 cm right of P in water
(3) 20 cm right of P in water
(4) 20 cm left of P in air

Ans. Option (1) is correct.

> ***Explanation***: Object distance, $u = -20$ cm
> Radius of curvature, $R = -10$ cm
> Refractive index of second medium, $\mu_2 = \frac{4}{3}$ and that of air medium, $\mu_1 = 1$.
> The image distance is
> $$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$
> $$\Rightarrow \quad \frac{4/3}{v} - \frac{1}{(-20)} = \frac{4/3 - 1}{(-10)}$$
> $$\Rightarrow \quad v = -16 \text{ cm}$$
> Hence, the final image is 16 cm left of P in air or towards the object side.

6. For fixed values of radii of curvature of lens, power of the lens will be__________.
Fill in the blank with the correct answer from the options given below.

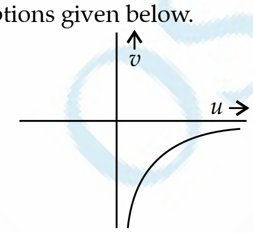
(1) $P \propto (\mu - 1)$ **(2)** $P \propto \mu^2$
(3) $P \propto \frac{1}{\mu}$ **(4)** $P \propto \mu^{-2}$

Ans. Option (1) is correct.

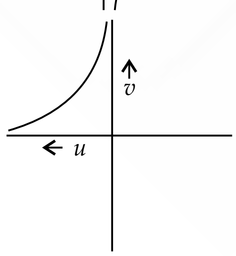
> ***Explanation***: Power of the lens is, $P = \frac{1}{f}$,
> Where f is the focal length of the lens.
> $$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$
> So, $$P = \frac{1}{f} \propto (\mu - 1)$$

7. The graph correctly representing the variation of image distance 'v' for a convex lens of focal length 'f' versus object distance 'u' is___________.
Fill in the blank with the correct answer from the options given below.

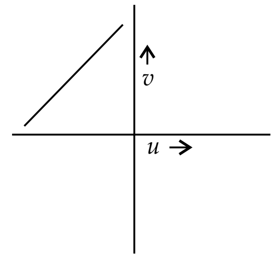
(1)



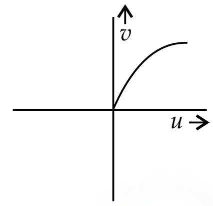
(2)



(3)

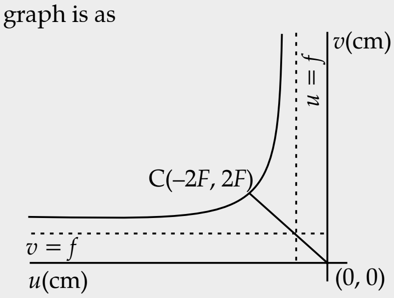


(4)



Ans. Option (2) is correct.

> ***Explanation***: For convex lens, $f = +$ve
> The lens formula is $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
> When, $u = -\infty, v = f$
> $u = -2f, v = 2f$
> $u \to f, v \to \infty$
> The graph is as



8. Using light from a monochromatic source to study diffraction in a single slit of width 0.1 mm, the linear width of central maximum is measured to be 5 mm on a screen held 50 cm away. The wavelength of light used is__________.
Fill in the blank with the correct answer from the options given below.

(1) 2.5×10^{-7} m **(2)** 4×10^{-7} m
(3) 5×10^{-7} m **(4)** 7.5×10^{-7} m

Ans. Option (3) is correct.

> ***Explanation***: The width of central maxima in diffraction is $\frac{2\lambda D}{a}$, where a is width of the slit, λ is the wavelength and D is the distance of the screen form the slit.
> So, $$\lambda = \frac{\text{width of central maxima} \times a}{2D}$$
> $$= \frac{5 \times 10^{-3} \times 0.1}{2 \times 50 \times 10^{-2}}$$
> $$= 5 \times 10^{-7} \text{ m}$$

9. Radiation of frequency $2\nu_0$ is incident on a metal with threshold frequency ν_0. The correct statement of the following is__________.

Fill in the blank with the correct answer from the options given below.

(1) No photoelectrons will be emitted

(2) All photoelectrons emitted will have kinetic energy equal to $h\nu_0$

(3) Maximum kinetic energy of photoelectrons emitted can be $h\nu_0$

(4) Maximum kinetic energy of photoelectrons emitted will be $2h\nu_0$

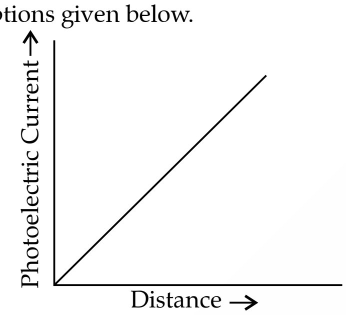
Ans. Option (3) is correct.

> ***Explanation***: The Einstein's photoelectric equation is
>
> $$KE_{max} = h\nu - h\nu_0$$
> $$= h(2\nu_0) - h\nu_0 = h\nu_0$$

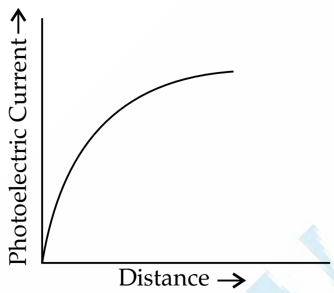
10. A point source causing photoelectric emission from a metallic plate is moved away from the plate. The variation of photoelectric current with distance from the source is correctly represented by the graph__________.

Fill in the blank with the correct answer from the options given below.

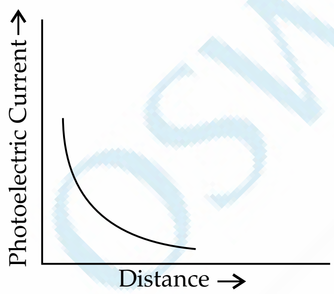
(1)



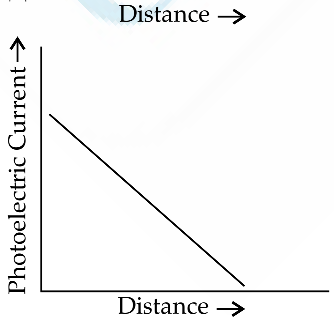
(2)



(3)

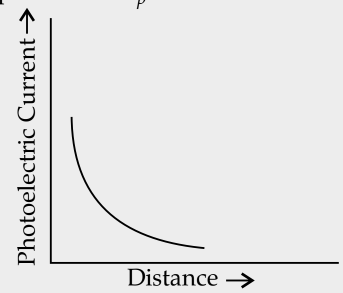


(4)



Ans. Option (3) is correct.

> ***Explanation***: The photo current (I_p) directly depends on intensity (I) of light incident and the intensity is inversely proportional to square of the distance(r) for a point source, i.e., $I_p \propto I \propto \frac{1}{r^2}$.
>
> So, the graph between I_p and r is



11. A proton accelerated through a potential difference V has a de Broglie wavelength λ. On doubling the accelerating potential, de Broglie wavelength of the proton___________.

Fill in the blank with the correct answer from the options given below.

(1) remains unchanged **(2)** becomes double

(3) becomes four times **(4)** decreases

Ans. Option (4) is correct.

> ***Explanation***: The de-Broglie wavelength associated with the proton accelerating through a potential difference of V is $\lambda = \frac{h}{\sqrt{2mqV}}$, where h, m and q are Planck's constant, mass of the proton and charge of the proton respectively.
>
> Hence, on doubling the potential difference, the wavelength becomes $\frac{1}{\sqrt{2}}$ times, so wavelength decreases.

12. The kinetic energy of an electron in ground level in hydrogen atom is K units. The values of its potential energy and total energy respectively are__________.

Fill in the blank with the correct answer from the options given below.

(1) $-2K; -K$ **(2)** $+2K; -K$

(3) $-K, +2K$ **(4)** $+K, +2K$

Ans. Option (1) is correct.

> ***Explanation***: The kinetic energy (KE), potential energy (PE) and total energy (TE) of a revolving electron are related as
>
> $$KE = -TE = -\frac{PE}{2}$$

13. Two nuclei have mass numbers A and B respectively. The density ratio of the nuclei is__________.

Fill in the blank with the correct answer from the options given below.

(1) $A : B$ **(2)** $\sqrt{A} : \sqrt{B}$

(3) $A^2 : B^2$ **(4)** $1 : 1$

Ans. Option (4) is correct.

> ***Explanation***: The nuclear density is constant (2.3×10^{17} kg/m^3) irrespective of the atom.

14. The shortest wavelengths emitted in hydrogen spectrum corresponding to different spectral series are as under:

(A) Pfund series **(B)** Balmer series
(C) Brackett series **(D)** Lyman series

The wavelengths arranged correctly in decreasing order are_________

Fill in the blank with the correct answer from the options given below.

(1) (A), (B), (C), (D) **(2)** (A), (C), (B), (D)
(3) (B), (A), (D), (C) **(4)** (A), (C), (D), (B)

Ans. Option (2) is correct.

> ***Explanation***: Lymann series falls in UV region, Balmer series falls in visible region and other series fall in Infrared region.
>
> As $\lambda_{UV} < \lambda_{visible} < \lambda_{IR}$

15. Silicon can be doped using one of the following elements as dopant:

(A) Arsenic **(B)** Indium
(C) Phosphorus **(D)** Boron

To get *n*-type semiconductor, the dopants that can be used are __________.

Fill in the blank with the correct answer from the options given below.

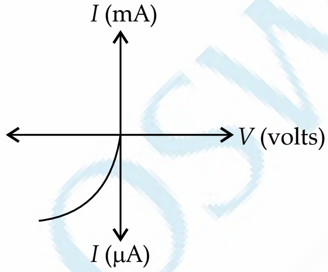
(1) (A) and (C) only **(2)** (B) and (C) only
(3) (A), (B), (C) and (D) **(4)** (C) and (D) only

Ans. Option (1) is correct.

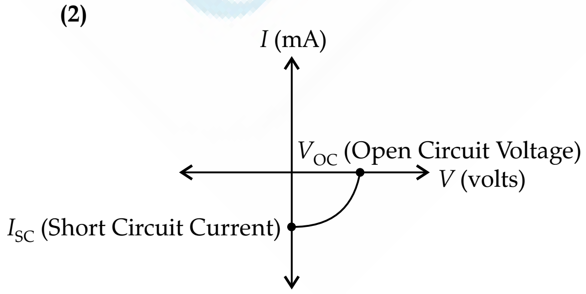
> ***Explanation***: For *n*-type semiconductors, pentavalent impurities are added such as phosphorous, antimony and arsenic etc.

16. Given below are *V* versus *I* graphs for different types of *p-n* junction diodes marked A, B, C and D.

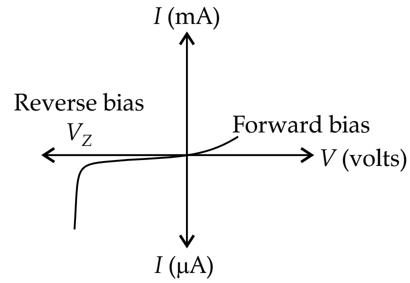
(1)



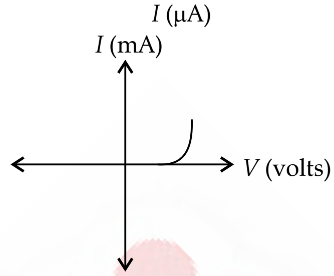
(2)



(3)



(4)



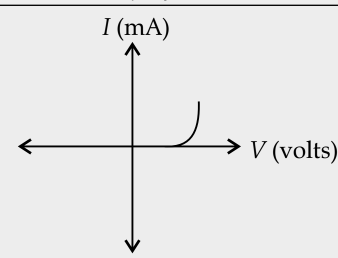
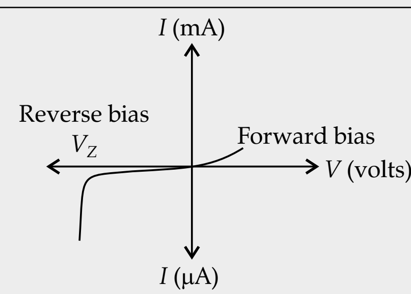
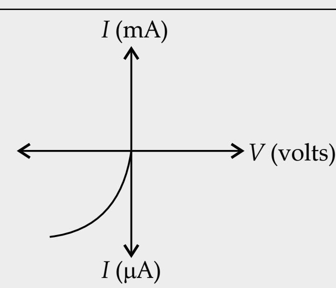
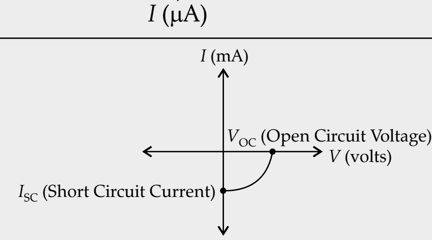
The correct sequence of graphs corresponding to forward biased *p-n* junction; Zener diode; Photo diode and Solar cell in order is___________.

Fill in the blank with the correct answer from the options given below.

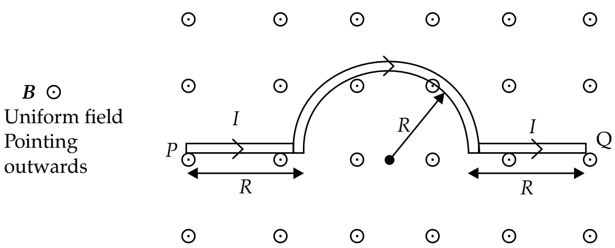
(1) (D), (C), (A), (B) **(2)** (A), (C), (B), (D)
(3) (B), (A), (D), (C) **(4)** (C), (B), (D), (A)

Ans. Option (1) is correct.

Explanation: **Forward biased *pn*-junction**

Forward biased pn-junction	
Zener diode	
Photo diode	
Solar cell	

17. A wire carrying current I, bent as shown in the figure, is placed in a uniform field B that emerges normally out from the plane of the figure. The force on this wire is__________.



Fill in the blank with the correct answer from the options given below.

(1) $4BIR$, directed vertically downward

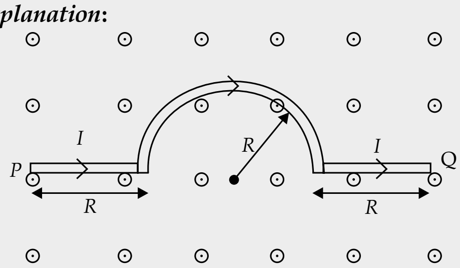
(2) $3BIR$, directed vertically upward

(3) $BI(2R + \pi R)$, vertically downward

(4) $2\pi BIR$, from P to Q

Ans. Option (1) is correct.

Explanation:



The force on a current carrying conductor in a uniform magnetic field (B) is $\vec{F} = I\vec{l} \times \vec{B}$

Here the effective length, $\vec{l} = 4R\hat{i}$ and $\vec{B} = B\hat{k}$

So, $\vec{F} = I(4R)\hat{i} \times B\hat{k}$

$= 4BIR(-\hat{j})$ or $4BIR$ vertically downward.

18. The refractive index of the material of an equilateral prism is $\sqrt{2}$. The angle of minimum deviation of that prism is__________.

Fill in the blank with the correct answer from the options given below.

(1) 60°	**(2)** 75°
(3) 30°	**(4)** 90°

Ans. Option (3) is correct.

Explanation: For an equilateral prism, the refracting angle is (A) 60°, the refractive index (μ) is $\sqrt{2}$, hence

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$, putting the values

The minimum deviation, $\delta_m = 30°$

19. The transfer of integral number of __________ is one of the evidence of quantization of electric charge.

Fill in the blank with the correct answer from the options given below.

(1) photons	**(2)** nuclei
(3) electrons	**(4)** neutrons

Ans. Option (3) is correct.

Explanation: All free charges are integral multiples of a basic unit of charge denoted by e. Thus charge q on a body is always given by $q = ne$ where n is any integer, positive or negative.

20. When a slab of insulating material 4 mm thick is introduced between the plates of a parallel plate capacitor of separation 4 mm, it is found that the distance between the plates has to be increased by 3.2 mm to restore the capacity to its original value. The dielectric constant of the material is________.

Fill in the blank with the correct answer from the options given below.

(1) 2	**(2)** 5
(3) 3	**(4)** 7

Ans. Option (2) is correct.

Explanation: The capacitance of a parallel plate capacitor without dielectric is, $C = \frac{\varepsilon_0 A}{d}$ and

with dielectric is $C' = \frac{\varepsilon_0 A}{d' - t + \left(\frac{t}{k}\right)}$

Where, the thickness of the slab t = 4mm, the plate separation is increased by, d' = t = 3.2 mm. As in both the cases capacitance is same, then

$$C = \frac{\varepsilon_0 A}{d} = \frac{\varepsilon_0 A}{(d'-t) + \left(\frac{t}{k}\right)}$$

$$\Rightarrow \quad d = (d'-t) + \left(\frac{t}{k}\right)$$

$$\Rightarrow \quad 4 = 3.2 + \frac{4}{k}$$

$$\Rightarrow \quad k = 5$$

Hence, the dielectric constant is k = 5

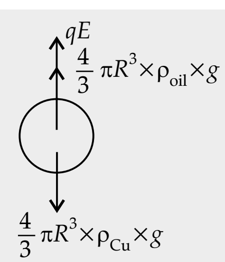
21. A copper ball of density 8.0 g/cc and 1 cm in diameter is immersed in oil of density 0.8 g/cc. The charge on the ball if it remains just suspended in oil in an electric field of intensity 600 V/m acting in the upward direction is__________.

Fill in the blank with the correct answer from the options given below. (Take $g = 10$ m/s^2)

(1) 2×10^{-6} C	**(2)** 2×10^{-5} C
(3) 1×10^{-5} C	**(4)** 1×10^{-6} C

Ans. Option (2) is correct.

Explanation:



For equilibrium condition, net force acting in the particle must be zero.

Hence, $qE + F_B = mg$

Where symbols have their usual meanings.

The buoyant force, $F_B = \frac{3}{4}\pi R^3 \times \rho_{oil} \times g$ and

weight $mg = \frac{4}{3}\pi R^3 \times \rho_{Cu} \times g$.

$$q = \frac{4\pi R^3(\rho_{Cu} - \rho_{oil})}{3E}$$

$$= \frac{4\pi \times (0.5 \times 10^{-2})^3 (8 - 0.8) \times 10^3}{600\pi}$$

$$= 2 \times 10^{-5} \text{ C}$$

22. A metal wire is subjected to a constant potential difference. When the temperature of the metal wire increases, the drift velocity of the electron in it__________.

Fill in the blank with the correct answer from the options given below.

(1) increases, thermal velocity of the electrons decreases

(2) decreases, thermal velocity of the electrons decreases

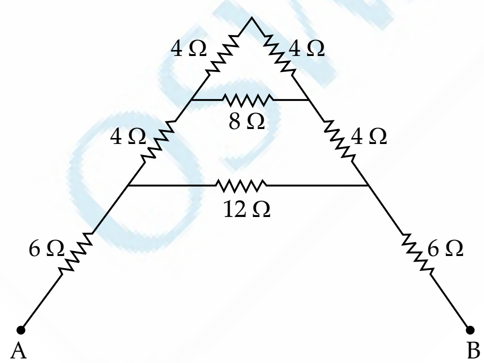
(3) increases, thermal velocity of the electrons increases

(4) decreases, thermal velocity of the electrons increases

Ans. Option (4) is correct.

Explanation: On increasing temperature kinetic energy (KE $\propto T$) of the free electron increases, so collision between the electrons and atoms increases. Hence, its relaxation time (τ) decreases and drift velocity decreases $\left(v_d = \frac{eV}{ml}\tau\right)$.

23. For the given mixed combination of resistors calculate the total resistance between points A and B.



Choose the correct answer from the options given below.

(1) 9 Ω **(2)** 18 Ω

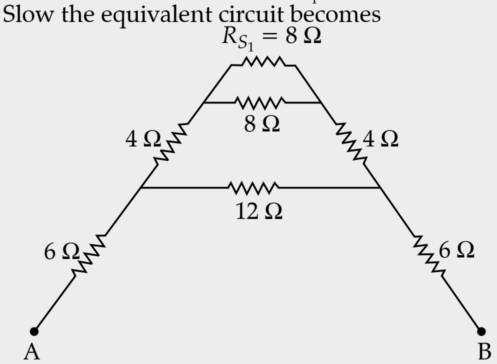
(3) 4 Ω **(4)** 14 Ω

Ans. Option (2) is correct.

Explanation: The two 4 Ω resistors at the top are connected in series.

So, $R_{S_1} = 4 \times 4 = 8\ \Omega$

Slow the equivalent circuit becomes

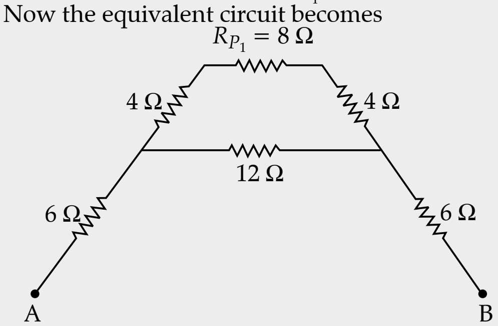


R_{S_1} and 8 Ω resistor are connected in parallel

So, $\frac{1}{R_{P_1}} = \frac{1}{8} + \frac{1}{8}$

$\Rightarrow$ $R_{P_1} = 4\ \Omega$

Now the equivalent circuit becomes



Now the three 4W resistors are connected in series.

So, $R_{S_2} = 4 + 4 + 4 = 12\Omega$

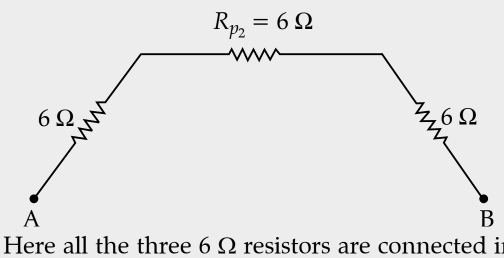
Now R_{S_2} and the 12 Ω resistors are connected in Parallel.

So, $\frac{1}{R_{P_2}} = \frac{1}{R_{S_2}} + \frac{1}{12}$

$\Rightarrow$ $\frac{1}{R_{P_2}} = \frac{1}{12} + \frac{1}{12} = \frac{2}{12}$

$\Rightarrow$ $R_{P_2} = 6\ \Omega$

So, the equivalent circuit becomes.



Here all the three 6 Ω resistors are connected in series.

So, the equivalent resistance between A and B is

$R = 6 + 6 + 6 = 18\ \Omega$

24. A cell of emf 1.1 V and internal resistance 0.5 Ω is connected to a wire of resistance 0.5 Ω. Another cell of the same emf is now connected in series with the intention of increasing the current but the current in the wire remains the same. The internal resistance of the second cell is

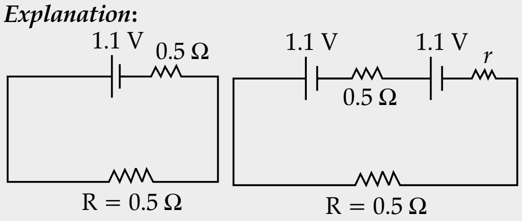
Fill in the blank with the correct answer from the options given below.

(1) 1 Ω (2) 2.5 Ω

(3) 1.5 Ω (4) 2 Ω

Ans. Option (1) is correct.

***Explanation*:**



(I) **(II)**

In case (I), the current flowing through the circuit is

$$I = \frac{E}{R+r}$$

$$= \frac{1.1}{0.5+0.5} \quad \text{...(i)}$$

In the case (II), the current is

$$I = \frac{2E}{r+r'+R}$$

$$= \frac{2.2}{r'+0.5+0.5} \quad \text{...(ii)}$$

In both cases, current is same,

$$\Rightarrow \quad \frac{1.1}{0.5+0.5} = \frac{2.2}{r'+0.5+0.5}$$

$$\Rightarrow \quad r' + 1 = 2$$

$$\Rightarrow \quad r' = 1\ \Omega$$

25. P, Q, R and S are four wires of resistances 3 Ω, 3 Ω, 3 Ω and 4 Ω respectively. They are connected to form the four arms of a wheatstone bridge circuit. The resistance with which S must be shunted in order that the bridge may be balanced is__________.

Fill in the blank with the correct answer from the options given below.

(1) 14 Ω (2) 12 Ω

(3) 15 Ω (4) 7 Ω

Ans. Option (2) is correct.

***Explanation*:** As $P = Q = R = 3\ \Omega$ and $S = 4\ \Omega$, the parallel combination of S and X should have on equivalent resistance of 3 Ω.

So, $$\frac{1}{3} = \frac{1}{S} + \frac{1}{X}$$

$$\Rightarrow \quad \frac{1}{3} - \frac{1}{4} = \frac{1}{X}$$

$$\Rightarrow \quad \frac{4-3}{12} = \frac{1}{X}$$

$$\Rightarrow \quad X = 12\ \Omega$$

26. Magnetic moment of a thin bar magnet is M'. If it is bent into a semicircular form, its new magnetic moment will be_________.

Fill in the blank with the correct answer from the options given below.

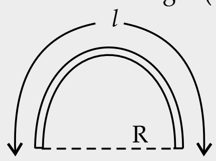
(1) $\frac{M}{\pi}$ (2) $\frac{M}{2}$

(3) M (4) $\frac{2M}{\pi}$

Ans. Option (4) is correct.

***Explanation*:** Magnetic moment (M)

= Pole strength (m) × length (l)



$$l = \pi R \Rightarrow R = \frac{l}{\pi}$$

Magnetic moment of the semicircle is

$$= \text{pole strength } (m) \times 2R$$

$$= m \times \frac{2l}{\pi}$$

$$= \frac{2M}{\pi}$$

27. Ferromagnetic material used in Transformers must have___________.

Fill in the blank with the correct answer from the options given below.

(1) Low permeability and High Hysteresis loss

(2) High permeability and Low Hysteresis loss

(3) High permeability and High Hysteresis loss

(4) Low permeability and Low Hysteresis loss

Ans. Option (2) is correct.

***Explanation*:** Ferromagnetic substance has high permeability and low hysteresis loss.

28. A conducting ring of radius r is placed in a varying magnetic field perpendicular to the plane of the ring. If the rate at which the magnetic field varies is x, the electric field intensity at any point of the ring is__________.

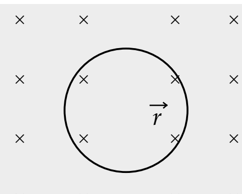
Fill in the blank with the correct answer from the options given below.

(1) rx (2) $\frac{rx}{2}$

(3) $2rx$ (4) $\frac{4r}{x}$

Ans. Option (2) is correct.

***Explanation*:**



$$\int \vec{E}_{in} \cdot \vec{dl} = \frac{d\phi_B}{dt}$$

$$E_{in} \times 2\pi r = \pi r^2 \frac{dB}{dt}$$

$$= \pi r^2 (x) \qquad \left[\because \frac{dB}{dt} = x\right]$$

$$E_{in} = \frac{rx}{2}$$

29. A 50 Hz ac current of crest value 1 A flows through the primary of a transformer. If the mutual inductance between the primary and secondary be 0.5 H, the crest voltage induced in the secondary is________.

Fill in the blank with the correct answer from the options given below.

(1) 75 V **(2)** 150 V

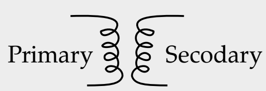
(3) 100 V **(4)** 200 V

Ans. Option (3) is correct.

***Explanation*:** $f = 50$ Hz

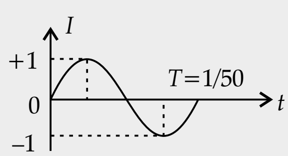
$$E_{\text{secondary}} = -M\frac{dI}{dt}$$

$$|E_{\text{secondary}}| = M\frac{\Delta I}{\Delta t}$$



As $f = 50$ Hz

$$T = \frac{1}{50} \text{ s}$$



$$\Delta I = 2\text{A and } \Delta t = \frac{1}{100} \text{ S}$$

So $$E_{\text{secondary}} = \frac{0.5 \times 2}{\frac{1}{100}} = 100 \text{ V.}$$

30. A long solenoid of diameter 0.1 m has 2×10^4 turns per meter. At the centre of the solenoid a coil of 100 turns and radius 0.01 m is placed with its axis coinciding with the solenoid axis. The current in the solenoid reduces at a constant rate to 0 A from 4 A in 0.05 s. If the resistance of the coil is $10\pi^2$ Ω, then the total charge flowing through the coil during this time is________.

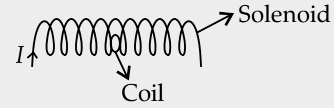
Fill in the blank with the correct answer from the options given below.

(1) 16 μC **(2)** 32 μC

(3) 16π μC **(4)** 32π μC

Ans. Option (2) is correct.

***Explanation*:**



$$B_{in} = \mu_0 n I$$

Charge flowing through the inside coil is

$$\Delta\phi = \frac{N\Delta\phi}{R}$$

$$= \frac{N(\Delta BA)}{R}$$

$$= \frac{100 \times \pi(0.01)^2 \times \mu_0 n \Delta I}{10\pi^2}$$

$$= \frac{100 \times \pi \times 10^{-4} \times 4\pi \times 10^{-7} \times 2 \times 10^4 (4-0)}{10\pi^2}$$

$$= 32 \times 10^{-6} \text{ C}$$

$$= 32 \text{ μC.}$$

31. Lower half of a convex lens is made opaque. Which of the following statement describes the image of the object placed in front of the lens?

(A) No change in image

(B) Image will show only half of the object

(C) Intensity of image gets reduced

Choose the correct answer from the options given below.

(1) (A) only **(2)** (B) only

(3) (C) only **(4)** (B) and (C) only

Ans. Option (3) is correct.

***Explanation*:** As lower half of the lens is made opaque, less light from the object will pass through the lens. So, intensity of the image gets reduced.

32. Two slits are made 0.1 mm apart and the screen is placed 2 m away. The fringe separation when a light of wavelength 500 nm is used is________.

Fill in the blank with the correct answer from the options given below.

(1) 1 cm **(2)** 0.15 cm

(3) 1.5 cm **(4)** 0.1 cm

Ans. Option (1) is correct.

***Explanation*:** In YDSE, the fringe width

$\beta = \frac{\lambda D}{d}$, where symbols have their usual meanings.

$$= \frac{500 \times 10^{-9} \times 2}{0.1 \times 10^{-3}}$$

$$= 10^{-2} \text{ m}$$

$$= 1 \text{ cm}$$

33. For an astronomical telescope having objective lens of focal length 10 m and eyepiece lens of focal length 10 cm, telescope's tube length and magnification respectively are__________

Fill in the blank with the correct answer from the options given below.

(1)	20 cm, 1	**(2)**	1000 cm, 1
(3)	1010 cm, 1	**(4)**	1010 cm, 100

Ans. Option (4) is correct.

> ***Explanation***: For astronomical telescope, at normal adjustment, magnifying power, $m = \frac{f_o}{f_e}$
> and tube length, $L = f_o + f_e$, where f_o and f_e are the focal length of objective eyepiece respectively.
> So, $L = 10\text{ m} + 10\text{ cm}$
> $= 10.10\text{ m}$
> $= 1010\text{ cm}$
> and $m = \frac{10\text{ m}}{10\text{ cm}} = 100$

34. According to Bohr's Model

(A) The radius of the orbiting electron is directly proportional to 'n'.

(B) The speed of the orbiting electron is directly proportional to $\frac{1}{n}$.

(C) The magnitude of the total energy of the orbiting electron is directly proportional to $\frac{1}{n^2}$.

(D) The radius of the orbiting electron is directly proportional to n^2.

Choose the correct answer from the options given below

(1)	(A), (B) and (C) only	**(2)**	(A), (B) and (D) only
(3)	(A), (B), (C) and (D)	**(4)**	(B), (C) and (D) only

Ans. Option (4) is correct.

> ***Explanation***: According to Bohr's model,
> radius of n^{th} orbit, $r_n \propto n^2$,
> velocity in n^{th} orbit, $v_n \propto \frac{1}{n}$,
> & Total energy of n^{th} orbit, $E_n \propto \frac{1}{n^2}$.

35. For a full wave rectifier, if the input frequency is 50 Hz, the output frequency will be_________.

Fill in the blank with the correct answer from the options given below.

(1)	50 Hz	**(2)**	100 Hz
(3)	25 Hz	**(4)**	0 Hz

Ans. Option (2) is correct.

> ***Explanation***: For a full wave rectifier,
> $f_{output} = 2 f_{input}$
> $= 2 \times 50$
> $= 100\text{ Hz}.$

36. For an electric dipole in a non-uniform electric field with dipole moment parallel to direction of the field, the force F and torque τ on the dipole respectively are_________.

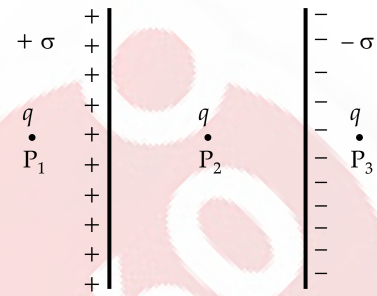
Fill in the blank with the correct answer from the options given below.

(1)	$F = 0, \tau = 0$	**(2)**	$F \neq 0, \tau = 0$
(3)	$F = 0, \tau \neq 0$	**(4)**	$F \neq 0, \tau \neq 0$

Ans. Option (2) is correct.

> ***Explanation***: In a non-uniform electric field, $\vec{F}_{net}$ on an electric dipole is not zero.
> As $\vec{E}$ is parallel to dipole, torque
> $|\vec{\tau}| = |\vec{p} \times \vec{E}|$
> $= PE \sin\theta$
> $= PE \sin 0 = 0$

37. Two large plane parallel sheets shown in the figure have equal but opposite surface charge densities $+\sigma$ and $-\sigma$. A point charge q placed at points P_1, P_2 and P_3 experiences forces F_1, F_2 and F_3 respectively. Then



Choose the correct answer from the options given below.

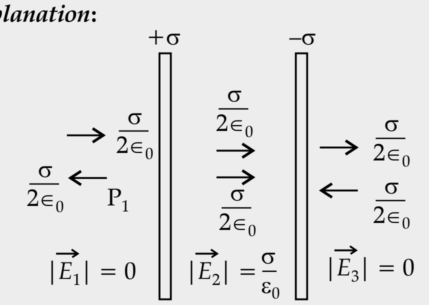
(1) $\vec{F}_1 = 0,\ \vec{F}_2 = 0,\ \vec{F}_3 = 0$

(2) $\vec{F}_1 = 0,\ \vec{F}_2 \neq 0,\ \vec{F}_3 = 0$

(3) $\vec{F}_1 \neq 0,\ \vec{F}_2 \neq 0,\ \vec{F}_3 \neq 0$

(4) $\vec{F}_1 = 0,\ \vec{F}_3 \neq 0,\ \vec{F}_2 = 0$

Ans. Option (2) is correct.

> ***Explanation***:
>
> 
>
>
> At P_1, $\vec{E}_{net} = \frac{\sigma}{2\epsilon_0}(-\hat{i}) + \frac{\sigma}{2\epsilon_0}\hat{i} = \vec{0}$
>
> At P_2, $\vec{E}_{net} = \frac{\sigma}{2\epsilon_0}\hat{i} + \frac{\sigma}{2\epsilon_0}\hat{i} = \frac{\sigma}{\epsilon_0}\vec{i}$
>
> At P_3, $\vec{E}_{net} = \frac{\sigma}{2\epsilon_0}\hat{i} + \frac{\sigma}{2\epsilon_0}(-\hat{i}) = \vec{0}$
>
> So $\vec{F}_1$ and $\vec{F}_3 = \vec{0}$
>
> and $\vec{F}_2 \neq \vec{0}$ $[\because \vec{F} = q\vec{E}]$

38. Two charged metallic spheres with radii R_1 and R_2 are brought in contact and then separated. The ratio of final charges Q_1 and Q_2 on the two spheres respectively will be__________.

Fill in the blank with the correct answer from the options given below.

(1) $\frac{Q_1}{Q_2} = \frac{R_2}{R_1}$ **(2)** $\frac{Q_1}{Q_2} < \frac{R_1}{R_2}$

(3) $\frac{Q_1}{Q_2} > \frac{R_1}{R_2}$ **(4)** $\frac{Q_1}{Q_2} = \frac{R_1}{R_2}$

Ans. Option (4) is correct.

Explanation: When two metallic spheres are made in contact, their potential becomes equal, i.e.,

$$V_1 = V_2$$

$$\Rightarrow \quad \frac{KQ_1}{R_1} = \frac{KQ_2}{R_2}$$

$$\left[\because V_{sphere} = \frac{KQ}{R}, \text{ from centre to surface}\right]$$

39. Two charged particles, placed at a distance d apart in vacuum, exert a force F on each other. Now, each of the charges is doubled. To keep the force unchanged, the distance between the charges should be changed to________.

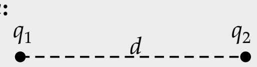
Fill in the blank with the correct answer from the options given below.

(1) $4d$ **(2)** $2d$

(3) d **(4)** $\frac{d}{2}$

Ans. Option (2) is correct.

Explanation:



Force (electrostatic) between two charges is

$$F = \frac{kq_1q_2}{d^2} \quad ...(1)$$

Now both the charges are doubled and distance between them has changed such that force remains as before,

So, $$F = \frac{k(2q_1)(2q_2)}{d'^2} \quad ...(2)$$

From (1) and (2)

$$d' = 2d$$

40. Two parallel plate capacitors of capacitances 2 μF and 3 μF are joined in series and the combination is connected to a battery of V volts. The values of potential across the two capacitors V_1 and V_2 and energy stored in the two capacitors U_1 and U_2 respectively are related as__________.

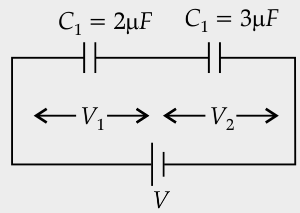
Fill in the blank with the correct answer from the options given below.

(1) $\frac{V_1}{V_2} = \frac{U_1}{U_2} = \frac{3}{2}$ **(2)** $\frac{V_1}{V_2} = \frac{U_1}{U_2} = \frac{2}{3}$

(2) $\frac{V_1}{V_2} = \frac{3}{2}$ and $\frac{U_1}{U_2} = \frac{2}{3}$ **(3)** $\frac{V_1}{V_2} = \frac{2}{3}$ and $\frac{U_1}{U_2} = \frac{3}{2}$

Ans. Option (1) is correct.

Explanation:



When capacitors are connected is series, charge through there are same.

So $$Q_1 = Q_2$$

$$\Rightarrow \quad C_1V_1 = C_2V_2$$

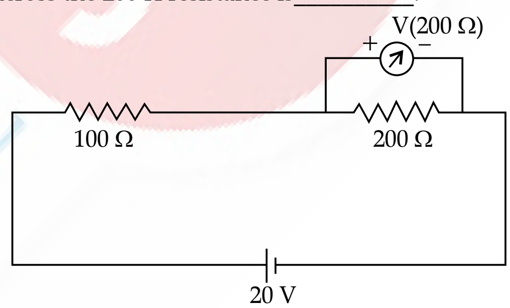
$$\Rightarrow \quad \frac{V_1}{V_2} = \frac{C_2}{C_1} = \frac{3}{2}$$

The energy stored in the capacitor in, U = $\frac{Q^2}{2C}$

So $$\frac{U_1}{U_2} = \frac{C_2}{C_1} = \frac{3}{2}$$

So, $$\frac{V_1}{V_2} = \frac{U_1}{U_2} = \frac{3}{2}$$

41. Two resistances of 100 Ω and 200 Ω are connected in series across a 20 V battery as shown in figure below. The reading in a 200 Ω voltmeter connected across the 200 Ω resistance is__________.



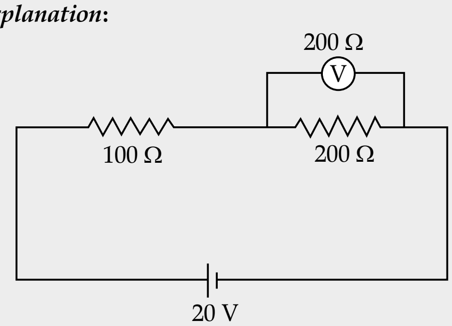
Fill in the blank with the correct answer from the options given below.

(1) 4 V **(2)** $\frac{20}{3}$ V

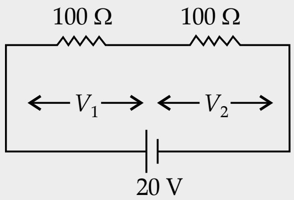
(3) 10 V **(4)** 16 V

Ans. Option (3) is correct.

Explanation:



Voltmeter has resistance 200 Ω, which is connected across a 200 Ω resistance in parallel. So, the equivalent circuit is



$$\frac{V_1}{V_2} = \frac{R_1}{R_2} = 1$$

$$V_1 + V_2 = 20$$

$$\Rightarrow \quad V_1 = V_2 = 10 \text{ V}$$

42. The current through a $\frac{4}{3}$ Ω external resistance connected to a parallel combination of two cells of 2 V and 1 V emf and internal resistances of 1 Ω and 2 Ω respectively is__________.

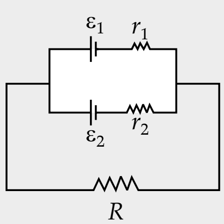
Fill in the blank with the correct answer from the options given below.

(1) 1 A **(2)** $\frac{2}{3}$ A

(3) $\frac{3}{4}$ A **(4)** $\frac{5}{6}$ A

Ans. Option (4) is correct.

***Explanation*:**



$$\varepsilon_{eq} = \frac{\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{R}}$$

$$= \frac{\frac{2}{1} + \frac{1}{2}}{\frac{1}{1} + \frac{1}{2} + \frac{1}{\left(\frac{4}{3}\right)}}$$

$$= \frac{10}{9}$$

$$I_R = \frac{\varepsilon_{eq}}{R} = \frac{\frac{10}{9}}{\frac{4}{3}}$$

$$= \frac{5}{6} \text{A}$$

43. A metallic wire of uniform area of cross section has a resistance R, resistivity ρ and power rating P at V volts. The wire is uniformly stretched to reduce the radius to half the original radius. The values of the resistance, resistivity and power rating at V volts are now denoted by R', ρ' and P' respectively. The corresponding values are correctly related as___________.

Fill in the blank with the correct answer from the options given below.

(1) $\rho' = 2\rho, R' = 2R, P' = 2P$

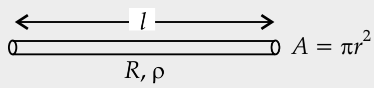
(2) $\rho' = \frac{1}{2}\rho, R' = \frac{1}{2}R, P' = \frac{1}{2}P$

(3) $\rho' = \rho, R' = 16R, P' = \frac{1}{16}P$

(4) $\rho' = \rho, R' = \frac{1}{16}R, P' = 16P$

Ans. Option (3) is correct.

***Explanation*:**



$$P = \frac{V^2}{R}$$

When the wire is stretched uniformly to reduce to half the original radius.

ρ is the property of the material.

So, it remains unchanged.

$$\rho' = \rho$$

Resistance, $R = \rho\frac{l}{A}$

$$= \rho\frac{l \times A}{A \times A}$$

$$= \rho\frac{\text{Volume}}{A^2}$$

$$R \propto \frac{1}{A^2} = \frac{1}{(\pi r^2)^2}$$

$\Rightarrow$ $R \propto \frac{1}{r^4}$

As $r \to \frac{r}{2}$

So, $R' = 16R$

Power, across the resistance is,

$$P = \frac{V^2}{R}$$

$$P \propto \frac{1}{R}$$

So, $P' = \frac{P}{16}$

44. Three magnetic materials are listed below

(A) paramagnetics **(B)** diamagnetics

(C) ferromagnetics

Choose the correct order of the materials in increasing order of magnetic susceptibility.

(1) (A), (B), (C) **(2)** (C), (A), (B)

(3) (B), (A), (C) **(4)** (B), (C), (A)

Ans. Option (3) is correct.

Explanation: Magnetic susceptibility, χ_m of ferromagnetic substances is very high and that of diamagnetic substances is very low.

So, $\chi_{diamagnetic} < \chi_{paramagnetic} << \chi_{ferromagnetic}$

45. Two infinitely long straight parallel conductors carrying currents I_1 and I_2 are held at a distance d apart in vacuum. The force F on a length L of one of the conductors due to the other is__________.

Fill in the blank with the correct answer from the options given below.

(1) proportional to L but independent of $I_1 \times I_2$

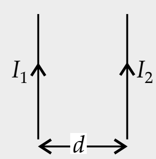
(2) proportional to $I_1 \times I_2$ but independent of length L

(3) proportional to $I_1 \times I_2 \times L$

(4) proportional to $\frac{L}{I_1 \times I_2}$

Ans. Option (3) is correct.

Explanation:



Force per unit length on the conductor is,

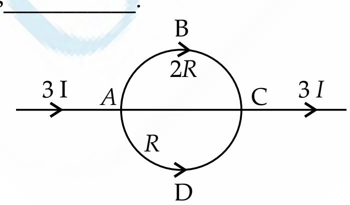
$$\frac{f}{l} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

So, force on the conductor of length L is

$$F = \frac{\mu_0 i_1 i_2}{2\pi d} \times L$$

So, $F \propto I_1 I_2 L$

46. In the circuit shown below, a current 3 I enters at A. The semicircular parts ABC and ADC have equal radii 'r' but resistances 2R and R respectively. The magnetic field at the center of the circular loop ABCD is__________.



Fill in the blank with the correct answer from the options given below.

(1) $\frac{\mu_0 I}{4r}$ out of the plane

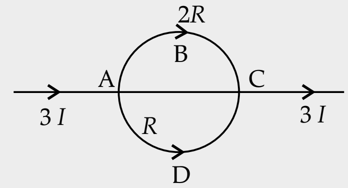
(2) $\frac{\mu_0 I}{4r}$ into the plane

(3) $\frac{\mu_0 3I}{4r}$ out of the plane

(4) $\frac{\mu_0 3I}{4r}$ into the plane

Ans. Option (1) is correct.

Explanation:



So, $I_{ABC} = 3I \frac{R}{3R} = I$

and $I_{ADC} = 3I \frac{2R}{3R} = 2I$

$$B_{ABC} = \frac{\mu_0 I}{4r} \otimes$$

$$B_{ADC} = \frac{\mu_0 (2I)}{4r} \odot$$

$$\vec{B}_{net} = \vec{B}_{ADC} + \vec{B}_{ABC}$$

$$= \frac{\mu_0 2I}{4r} \odot + \frac{\mu_0 I}{4r} \otimes$$

$$= \frac{\mu_0 I}{4r} \odot$$

47. A square loop with each side 1 cm, carrying a current of 10 A, is placed in a magnetic field of 0.2 T. The direction of magnetic field is parallel to the plane of the loop. The torque experienced by the loop is__________.

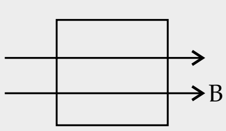
Fill in the blank with the correct answer from the options given below.

(1) zero **(2)** 2×10^{-4} Nm

(3) 2×10^{-2} Nm **(4)** 2 Nm

Ans. Option (2) is correct.

Explanation:



Torque, $\vec{\tau} = \vec{M} \times \vec{B}$

$\vec{M} = NIA$

$= 10 \times 10^{-4}$ Am^2

$\tau = MB \sin 90°$

$= 10 \times 10^{-4} \times 0.2$

$= 2 \times 10^{-4}$ Nm

48. In an ac circuit, the current leads the voltage by $\frac{\pi}{2}$.

The circuit is_________.

Fill in the blank with the correct answer from the options given below.

(1) purely resistive

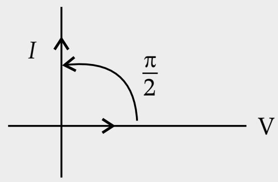
(2) should have circuit elements with resistance equal to reactance.

(3) purely inductive

(4) purely capacitive

Ans. Option (4) is correct.

Explanation: In purely capacitive circuit (ac), current leads by $\frac{\pi}{2}$ with voltage.



49. In a pair of adjacent coils, for a change of current in one of the coils from 0 A to 10 A in 0.25 s, the magnetic flux in the adjacent coil changes by 15 Wb. The mutual inductance of the coils is_________.

Fill in the blank with the correct answer from the options given below.

(1) 120 H **(2)** 12 H

(3) 1.5 H **(4)** 0.75 H

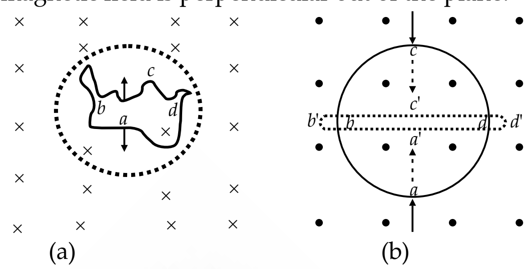
Ans. Option (3) is correct.

Explanation: $\Delta\phi = M\Delta I$

$\Rightarrow$ $15 = M \times 10$

$\Rightarrow$ $M = 1.5$ H

50. A wire of irregular shape in figure (a) and a circular loop of wire in figure (b) are placed in different uniform magnetic fields as shown in the figures below. In figure (a), the magnetic field is perpendicular into the plane. In figure (b), the magnetic field is perpendicular out of the plane.



The wire in figure (a) is turning into a circular loop and that in figure (b) into a narrow straight wire. The direction of induced current will be_________.

Fill in the blank with the correct answer from the options given below.

(1) clockwise in both (a) and (b)

(2) anti clockwise in both (a) and (b).

(3) clockwise in (a) and anti clockwise in (b)

(4) anti clockwise in (a) and clockwise in (b)

Ans. Option (2) is correct.

Explanation: Applying Lenz's law, the current will be induced in such a way that, it'll oppose the cause which produces it.

In fig (a) inward flux will increase when it becomes circular hence an anti-clockwise current will be induced.

In fig (b), outward flux will be decreased when it becomes narrow, so an anti-clockwise current will be induced here.

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